

HUMAN EXPLORATION OF THE SOLAR SYSTEM SYMPOSIUM (A5)
Human Exploration of the Moon and Cislunar Space (1)

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HUMAN-ASSISTED SAMPLE RETURN FROM THE MOON AND MARS USING THE ORION
SPACECRAFT

Abstract

Current plans for the next steps in the human exploration of deep space include sending astronauts to the vicinity of the Moon, such as a libration point halo orbit or Distant Retrograde Orbit (DRO). One useful science objective for such missions is to collaborate with a robotic lunar lander / ascent vehicle in order to collect geological samples from lunar farside and return them to the Earth. Returning samples from the SPA basin on the farside of the Moon has been identified as a priority in planetary science Decadal Surveys because it would help scientists understand the early dynamics and impact history of the solar system. Studies by JPL of a human-assisted derivative of the all-robotic MoonRise mission suggest that a human-assisted sample return could increase the feasible sample mass by a factor of ten, because the robotic lander/ascent vehicle would not carry an Earth-return capsule with its parachute and heatshield down to the surface of the Moon and back up again. Instead, the sample could be transferred in space to the Orion spacecraft currently being built by NASA and ESA, and returned to Earth with the astronauts.

Lockheed Martin is studying and testing concepts that provide Orion with the capability to rendezvous with a Lunar Ascent Vehicle and transfer samples collected from the lunar surface in a project called OSCAR (Orion Sample Capture And Return). Using our Space Operations Simulation Center – a full scale, high fidelity relative navigation test facility – we have shown that the Orion Vision Navigation System (VNS) flash lidar can detect and track a passive spherical sample container outfitted with retro-reflectors at distances from 2 km to capture. In addition, we present a conceptual design for an external module that would serve as a small sample transfer airlock on Orion, and would also provide additional stowage volume. The module would be discarded prior to Earth entry.

Retrieving a lunar sample in the Moon's vicinity could be a precursor for a human-assisted Mars sample return mission. A robotic Mars sample return spacecraft could bring a sample container to circum-lunar space (such as a distant retrograde orbit), then astronauts would be sent to retrieve the sample using similar protocols and technologies developed for the lunar mission. The primary difference for a Mars

sample mission is the addition of strict planetary protection requirements, which complicate the transfer and handling of the Martian sample vault.